MODERN ADAPTATION APPROACH OF WATER CONSUMING BRANCHES TO CLIMATE CHANGES AND DEGRADATION OF GLACIERS

P. I. Normatov

Meteorology Faculty, Tajik National University, Dushanbe, 734025, Tajikistan,

E-mail: umarova52@gmail.com

Abstract

It is known that the main waterways of Central Asia are Transboundary and respectively in relationship of the upstream and downstream countries of rivers the question of quantity and quality of waters are dominating. It is caused in distinction of interests in irrigational (the lower reaches countries) and power aspects of waters of the Transboundary rivers. One of such Transboundary rivers is Continuous monitoring of the water resources condition is necessary for planning of development of basin by the account of power and irrigational interests. The present article is devoted to more detailed analysis and estimates of the prompt degradation of glaciers of the basin, quality of the Zeravshan River waters and formation of floods by essential economic damages and definition of adequate possibility measures for their mitigation. For this purpose meteorological data of Agency of hydrometeorology of Tajikistan, methods of the chemical analysis of waters of the river and statistical data of the Ministry of Emergency Situations of Tajikistan were widely used. In most cases the problem of water quality of the Zeravshan River consider in organic communication with activity of the Anzob Mountain-concentrating Industrial Complex (AMCIC) in Tajikistan. Results of comparison of the analysis of waters have shown about absence of essential pollution of waters of the Zeravshan River by wastewaters of the Anzob mountain-concentrating industrial complex but are changed under the influence of collector drainage water of irrigating basin zone and wastewater of Samarqand, Kattakurgan, Navoi and Bukhara cities of Uzbekistan

Key words: Glacier, flood, agriculture, Hydropower, pollution, mountain.

Introduction

In the Aral Sea Basin on the territory which is located five states, water resources are used basically for irrigation and water-power engineering. These water users demand different modes of regulation of a river drain. In interests of water-power engineering – the greatest development of the electric power and accordingly use larges parts of an annual drain of the rivers in winter the cold period of year. For irrigation the greatest volume of water is required in the summer during the vegetative period. Regulation of a river drain is thus carried out by the large reservoirs. Thus all largest hydroelectric power stations are constructed in the countries of a zone of the drain formation - in upstream the rivers Amudarya and Syrdarya – in Kyrgyzstan and Tajikistan and the main areas of the irrigated lands are located in states of the down stream of the rivers – Kazakhstan, Turkmenistan and Uzbekistan [1].

Among calls which the whole world faced it is climate change which poses serious threat for all natural and economic complexes including water and land resources.

In condition of Central Asia the issue of assessing the present and estimated changes of glaciations have a basic importance for two reasons [2]:

- glaciers are clear indicators of the natural environment reaction to the climate changes: the rate of average annual temperature increase by less than 1.0 ^{o}C a century was enough for the glaciations in the mountains of Central Asia to be reduced by more than a third;

- it is equally important to estimate the impact of the present glacier ice retreat on the characteristics of river drain and water resources.

The Glaciers of Tajikistan occupied about 6% territories of the country and to make an important contribution in water flow formation of the Amudarya River - the largest waterway of the Central Asia and Aral Sea Basin.

Annually in average 10-20 % of the large rivers drain formed at thawing glaciers of the Tajikistan and in dry and hot years the contribution of glaciers to water resources of the same rivers in summer can reach 70%. Getting warmer in high-mountainous areas of Tajikistan (Pamir, Zeravshan and Gissar-Alay) corresponds to regional and global tendencies of the climate change and stimulated appreciable changes in glaciers. The estimation of influence of global climate change on glaciers of Tajikistan has shown that for all period of observation since 1930 years the total area of glaciations of the Tajikistan was reduced approximately to one third.

The accounting of change of climatic factors (temperature and evaporation reduction, increase in a precipitation and humidity) gives to economy of water for an irrigation of agriculture lands about 2000 m^3 per ha.

The presented examples clear are demonstrated about necessity of development of scientifically reasonable mechanisms of adaptation of all components of an ecosystem to climate changes.

The paper is devoted to the analysis of a condition of glaciers of a river basin of Zeravshan and development of modern approaches on a sustainable development of a river basin taking into account interests of hydro power and irrigation

Zeravshan is Transboundary River in Uzbekistan and Tajikistan - length of 877 km, the area of basin of 17.7 Th. km^2. The average expense of water 162 m^3/sec. Originates from the Zeravshan glacier in mountain knot between Turkestan and Zeravshansk with ridges the river is fed basically with glaciers and snow. Therefore the greatest drain in it is necessary for the summer (July, August), during the cold period of year Zeravshan bears not enough water. In the summer water in the river muddy, gray-steel color, in the winter pure and transparent. On territories of Republic Uzbekistan near to the Samarkand city the Zeravshan River is divided into two sleeves – Akdarya and Karadarjua. Earlier Zeravshan ran to Amudarya River but now loses the waters in desert Kyzyl Kum, forming two deltas – Karakulsk and Bukhara. The total drain of the Zeravshan River Basin on the periods 1932-1962 and 1962-1991 make is accordingly 146.26 and 145.03 km^3 [3]. The water of the Zeravshan River on the Republic Uzbekistan territory is distributed basically on following areas: Samarkand-70.2 % (at irrigated area of 67 %), Navoi-13.1 % (at irrigated area of 16 %), Dzhizak-7.4 % (at irrigated area of 8.6 %), Kashkadarya- 9.3% (at irrigated area of 7.8 %) [4].

From the total water intake of the Zeravshan River (4834 mln.m^3) to the Republic of Tajikistan to come only 253 mln. m^3 (5.23 %) [5].

Materials and Methods

By our preliminary researches it was established that in the Zeravshan River Basin water and power and ecological aspects become more actual in connection with appearance of the following problems:

- prompt degradation of glaciers of the basin;

- formation of floods by essential economic damages.

The present article is devoted to more detailed analysis and estimates of the above-named problems and definition of adequate possibility measures for their mitigation

For this purpose meteorological data of Agency of hydrometeorology of Tajikistan, methods of the chemical analysis of waters of the river and statistical data of the Ministry of Emergency Situations of Tajikistan were widely used.

Results and discussion

Glaciers of the Zeravshan River Basin

Zeravshan. The glacier is located on the Zeravshan and Turkestan ridges joints and gives rise to one of the main rivers of the Central Asia – Zeravshan River. It is dendrite glacier by length of 27.8 km, the area 38.7 km^2 and with inflows 132.6 km^2.The tongue of the glacier takes place on 2810 m above sea level. Moraines of the Zeravshan glaciers occupy 10 km^2 and with inflows 24 km^2 areas. Observation of the Zeravshan River water discharge are begun from the end of a 19^{th} Century on the Dupuli Hydropost and since 1927 years are begun detailed observation of the Zeravshan glaciers.

Rama. The glacier is located on a southern slope of the Turkestan ridge in upstream of the Zeravshan River in narrow rocky gorge. It is a valley's glacier by length of 8.9 km and the area 22.3 km^2. The end of the tongue of the glacier takes place on 3500 m a. s. l. and is covered by the moraine 3 km^2. As well as all other glaciers of the Zeravshan River Basin the Rama glacier recedes.

Tro. The glacier is located on the southern slope of the Turkestan ridge in sources of Zeravshan River. A glacier is valleys by length of 3.0 km and the area 2.2 km^2. The tongue of the glacier takes place on 3920 m. a. s. l. and buries in a final moraine. Observations of the glacier are begun in 1959.

Dikhadang. The glacier is located in the Zeravshan River Basin on northern slope of the Zeravshan ridge. The glacier is valleys by length of 2.2 km and the area 2.0 km^2. Dikhadang glacier is covered by a moraine 0.3 km^2. The tongue of the glacier is located on 3600 m a. s. l. Observation of the glacier are begun in 1959.

HGP (Hydrographic party). The glacier is located on northern slope of Hissar Mountains in the Saritag River Basin running to Lake Iskandarkul. The length of a glacier is 1.16 km by the area 0.54 $km^2$and average width of 0.47 km. The glacier end lies at height of 3320 m. a. s. l. The first

observations on a glacier are spent in 1968 and in 1971-1974 periods on a glacier every summer worked complex glacial expedition. For last 16 years (1990 - 2006 years) a glacier has receded on 35-55 m (Fig.1) annually the average its speed has made about 3 m per year though in the eightieth years of the last century it has made about 8 m annually. Shooting of a cross-section structure has shown that the glacier has not changed almost, and recedes only from a final part. Thus, the nearest decade's disappearance does not threaten glacier HGP.

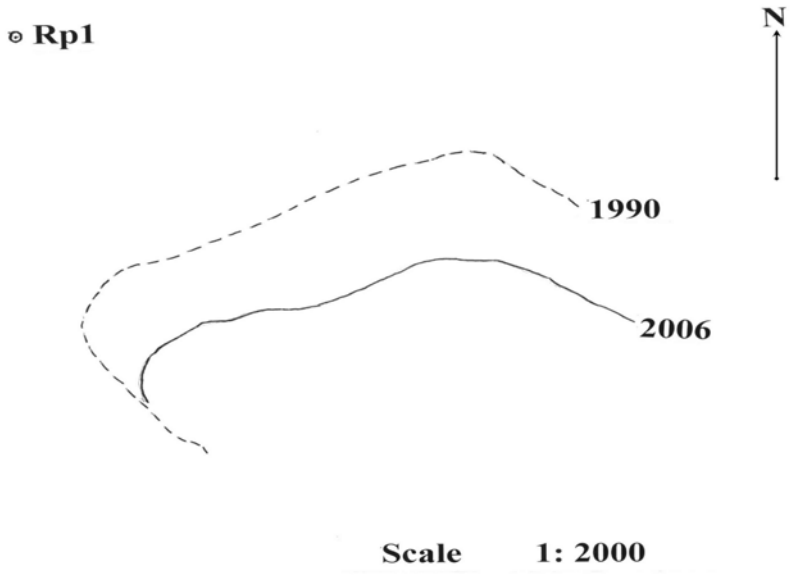


Figure 1 Deviation of the Hydrogeography Party glacier.

The question of Climate change influence on the glaciers state very actually in the Zarafshon River Basin (Table 1 & 2).

Table 1 Dynamics of change of the Zeravshan River Basin glaciers.

Name	Periods	Deviation	Deviation	Note
Zeravshan	1927-1961	280		In the period 1927-1976
	1961-1976	980	65	From ice set free the area 1.19 km^2
Rama	1929-1948		4	
	1948-1975		9	
	1976-1989		15	
	1989-1991		60	
	1929-1975	320		From ice set free the area 0.12 km^2
	1976-1991	356		From ice set free the area 30.0 km^2
Tro	1976-1988	18	1-2	
	1988-1990	60	30	
	1990-1991	23	23	
Dikhadang	1977-1991	180	13	
	1990-1991	60	60	
HGP	1968-1976	18	2.2	
	1982-1990	63	7.9	
	1989-1990	12	12	

Source: Tajik Hydrometeorology Agency

Table 2 Possible changes of the Zeravshan River Basin glaciers for the period to 2050.

Name of Glacier	Reduction		
	Length (km)	Area (km^2)	Volume (%)
Zeravshan	4.0-5.0	25-30	30-35
Rama	1.5-2.0	3.0-3.5	25-30
Tro	0.5-1.0	1.0-1.2	30-35
Dikhadang	1.2-1.5	1.0-1.5	more 50
HGP	Completely will thaw to 2030 years		

Source: Tajik Hydrometeorology Agency

Hydroenergy potential of the Zeravshan River Basin. It is necessary to notice that for the Republic of Tajikistan is perspective the energy potential of waterways of the Zeravshan river basin which according to [5] makes – 11.8 Bln. kWt·h. Potential hydropower resources of some inflows of the Zeravshan River present on the table 4.

In the presence of such rich energy potential suspended to the Zeravshan River Basin in Sogd area huge deficiency of the electric power is observed - 3-4 Bln. kWt·h /year which is covered by import of the electric power from the Republic of Uzbekistan. The intensive grows of the Tajikistan population, presence of the large file of the fertile but not mastered lands suspended to upstream of the Zeravshan River demands principal processing of economic use of the Zeravshan Rivers scheme. The mutual combination of interests of upstream and downstream countries of the Zeravshan River is quite achievable by building of the cascade of Hydropower station (HPS) with regulation of the river drain.

Table 3 Potential hydropower resources of some inflows of the Zeravshan River [6].

Name	Length, m	Average annual discharge, m^3/sec	Average annual power, Th. kWt	Average annual production, Mln. kWt·h
Sarmad	22.6	1.52	9.15	80.2
Artuchdarya	17.14	1.26	8.65	75.8
Magiandarya	68.4	10.3	76.5	670.0
Shing	14.2	5.89	20.0	176.0
Fondarya	24.5	61.1	396.0	3470.0
Tagobikul	19.8	2.83	17.1	150.0
Hasorchashma	12.4	1.70	10.8	94.2
Pindar	12.3	1.64	12.8	112.0
Dzijikurut	17.4	1.59	14.9	130.0
Gaberut	10.1	0.84	4.14	36.3
Iskandardarya	20.4	21.1	106	927.0
Saritag	34.0	13.5	68.5	560.0
Pasrud	28.4	4.68	13.8	121.0
Turo	12.7	2.07	10.1	94.0
Yarm	11.1	1.48	11.1	97.2
Demunora	19.6	3.0	24.1	210.0
Jindon	18.8	1.61	12.1	105.0

It causes some discontent of Republic Uzbekistan connected by that realization of programs on development of a hydropower potential of the river by building a number of the water reservoirs leads to deficiency of water in vegetation period of agricultural crops.

The cardinal solution of the conflict situation between an irrigation and water-power engineering is the greatest their joint development by building of new HPS with reservoirs. For water-power engineering it means increase in production of cheap and ecological pure energy and for an irrigation – increase of depth of long-term regulation of a drain and water security of already mastered lands, and also possibility of development new. At presence of several HPS with reservoirs the top reservoir can work only in power mode, the bottom reservoir of the same volume can regulated a drain up to restoration of its natural regime. Especially it can provide drain regulation in interests of irrigation. At presence not two but many quantities of HPS with reservoirs the situation even more will improve [1].

Thus, the analysis of the above-stated material is demonstrated that the solution of a problem of balanced use of two aspects, namely use of a hydroenergy potential of the Zarafshon River with full satisfaction of requirements of agriculture on water demands the deep feasibility report leaves on a plane of bilaterial negotiations of the adjoining countries. It seems to us that at the present stage in Global climate change by the most important monitoring and a behavior estimation hydro- and meteorological parameters of the Zeravshan River Basin to climate changes which allows to plan and adapt development and water-power engineering and agriculture taking into account forthcoming values of volume of the rivers water on immediate prospects is.

Ecological and social-economical estimation of the flood impacts in Zeravshan River Basin. Among all the regions of Tajikistan 93 % of territory which borrow mountains in the Zarafshon River Basin the formation of floods is observed most often (almost 7% of the total across Tajikistan) and their average number in a year reaches 150. More than 300 thousand inhabitants live in the Zarafshon River Basin located in the Ajni and Penjikent regional centers. The local population is affected almost annually with great economic losses (Fig.2, 3).

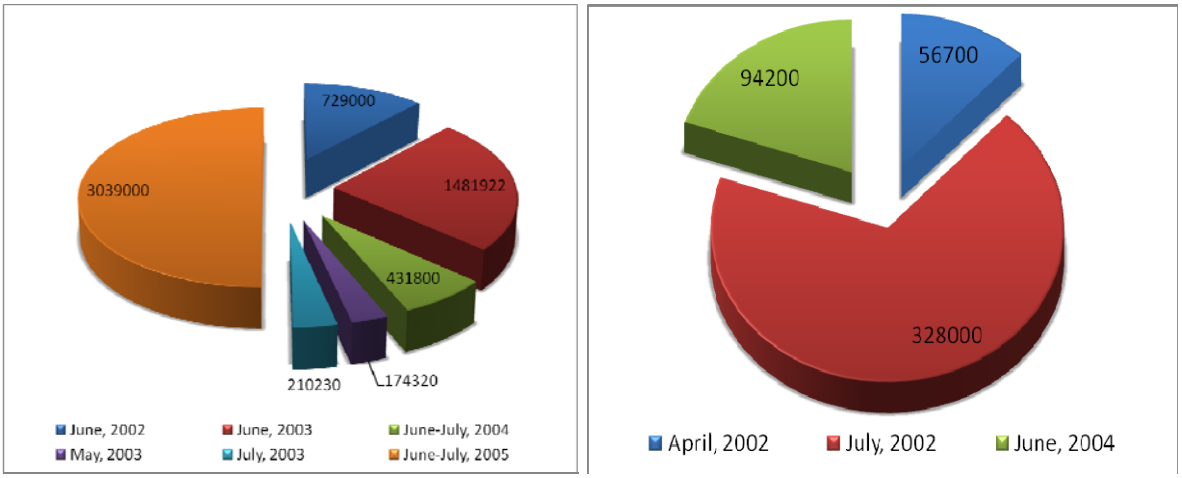
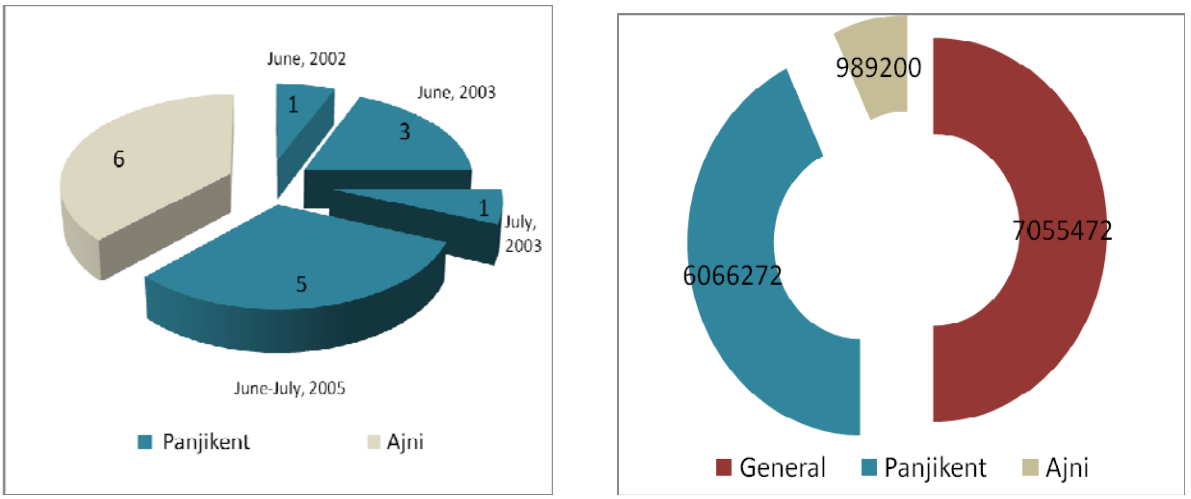


Figure 2 Economical damage of the floods in Penjikent (a) and Ajni (b) district (US Dollars).



a) **b)**

Figure 3 Total human victims of flooding in Ajni and Penjikent districts (person)(a) and total economical damage of Ajni and Penjikent districts in results of floods (2002-2005)(b)

Conclusion

It is established that in the conditions of Global climate change and its influence on all components of an ecosystem to become actual a problem of development of adequate and modern methods of adaptation of human activity to cataclysms of climate. In agriculture first of all substantial increase of efficiency of irrigation water and a farmland and wide involvement of biotechnology for selection high-efficiency and steady against stressful situations of grades is necessary. In the hydropower production direction this effective placement of hydropower station with reservoirs and stability of dams.

References

[1] G. N. Petrov, I. Sh. Normatov, Conflict of Interests between Water Users in the Central Asian Region and Possible Ways to its Elimination, Water Resources 37(2010) 113–120.

[2] V.M. Kotlyakov, I.V. Severskiy, Glaciers of Central Asia: modern condition, changes, possible impact to water resources, in: Materials of Intern. Seminar on Snow-ice and water resources of the Asian High Mountains, 2007, pp.21-55.

[3] V. G. Konovalov, M. V. Williams, Long-term fluctuations of glacier processes and river runoff in Central Asia under current climatic conditions, Meteorology and Hydrology 9(2005) 52-64.

[4] M.F. Abduraimov, Problems of Zarafshon hydrographic basin, in: Report NGO Protection of a river basin of Zarafshon, 2007.

[5] D.N. Nurmakhmadov, Hydropower of Tajikistan: current state and development prospect, in: Report on the International Conference on. Status, problems and prospects of development of banking system in Central Asian Republics in the stage of transition to market relationship, Dushanbe, Tajikistan, 2005.

[6] G.V Koshlakov, A.M. Babaev, D. Dzhuraev, Complexes socially-economical development of the mountain Zeravshan underzone, in: book of Problems of the socially-economical development of the Republic of Tajikistan, Dushanbe, 1988. p.18.